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Effects of different milk replacers on carcass traits, meat quality, meat color and fatty acids profile of dairy goat kids

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ABSTRACT

The aim of the work is to evaluate the effect of diet (goat milk, warm milk replacer or acidified milk replacer) on the growth, slaughtering performances, meat quality and fat composition of suckling kids of the Saanen breed. A total of 120 Saanen kids were used for the trial. They were born within 48 h from 60 goats that had the twin parturition. They were randomly divided into three treatment experimental group, each made up of 40 animals, of both sex, and housed in three different pens. One group was fed with natural milk by their dams, and kids remained with their mothers until 45 days of life. One group was fed with a milk replacer and one group was fed with an acid milk replacer. Live weight, hot and cold carcass weight, dressing percentage, chemical composition and fatty acids profile and meat colorimetric parameters were investigated. No effects were observed on live weight, carcass weight, dressing percentage and carcass composition. Fatty acid profile was affected by feeding system. Kids fed with goat milk showed meat richer in some saturated fatty acids as C10:0, C17:0 ($P < 0.05$), C14:0, C16:0 ($P < 0.01$). Meat of kids fed with acid milk replacer showed lower concentration of total SFA ($P < 0.01$) and higher concentration of total MUFA, PUFA ($P < 0.05$) and UFA ($P < 0.01$). Moreover, meat color seems to be affected by warm milk replacer, in fact meat was characterized by lower lightness and higher yellowness and hue. Artificial suckling seems to improve the FA quality of kids meat, improving the PUFA quantity. In fact, the increased consumption of foods with low level of saturated fatty acids (SFA) and high level of polyunsaturated fatty acids (PUFA), containing a low *n*-6/*n*-3 fatty acid ratio correlates with favorable human health conditions. Moreover, artificial feeding could improve milk quantity destined to market in order to improve its profitability.

1. Introduction

Goats are ruminants characterized by a good adaptability, characteristic that make possible its breeding on pastures not easily accessible to other livestock species, and they provide meat, milk and dairy products well appreciated by consumers throughout the world (Pazzola et al., 2011; De Smet, 2012). Traditionally, in the Mediterranean basin almost all sheep and goats belong to dairy breeds, where milk is the main product and lamb and kid meat are considered as by-products of the small ruminant dairy production (Arguello et al., 2007; Boyazoglu and Morand-Fehr, 2001; Harvey and Rigg, 1964). Goat meat is considered lean (Banon et al., 2006), with just the 1% of fat, and contains more polyunsaturated fatty acids in comparison with meat from other ruminants (Banskalieva et al., 2000). Goat meat production is strictly linked to its territory. In fact, local production systems are able to affect weight at slaughter and consequently carcass weight, and this results in many different products (Zervas and Tsiplakou, 2011 Zygogiannis, 2006). However, the main breeding systems involved in goats meat production are the extensive (grazing) and the intensive (indoor) ones, with significant and substantial differences between them (Joy et al., 2008; Zervas et al., 1999a,b). In both feeding systems. the use of dams milk for feeding is expected. In any case, the main role of dairy goat farming is to yield marketable milk, so early weaning of kids is important if milk is to be sold at a good price in order to increase farm profitability (Delgado-Pertínez et al., 2009a,b). In fact, traditionally, goats were reared with their dams, but this practice results in a decreased milk yield and thus less milk available for selling or cheese manufacturing (Lopez, 1990). Artificial suckling is closely linked to their intensification and to their specialization in milk production (Argüello et al., 2004). Moreover, available milk replacers are cheaper than natural goat milk and are specially for-

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Table 1
Gross composition and mineral-vitamin composition of the two milk replacers used in the trial

Chemical composition (%)	Warm milk replacer	Acid milk replacer
Gross protein	24.0%	20.0%
Total fat	24.0%	15.5%
Ash	7.0%	9.40%
Cellulose	0.0%	0.05%
Moisture	5.0%	3.30%
Sodium	–	0.65%
Vitamin A	50000 IU/kg	45000 IU/kg
Vitamin D_3	6000 IU/kg	5000 IU/kg
Vitamin E	100 IU/kg	150 mg/kg
Vitamin C	–	300 mg/kg
Iron (iron (II) sulphate)	–	100 mg/kg
Zinc (zinc sulphate)	–	70 mg/kg
Manganese (manganese sulphate)	–	55 mg/kg
Copper (copper (II) sulphate)	3 mg/kg	–
Iodine (calcium iodate)	–	1 mg/kg
Selenium (sodium selenate)	0.2 mg/kg	0.25 mg/kg

Table 2
Fatty acid composition of goat milk and milk replacers expressed as% of total FAME in the three milk used in the trial (mean from analysis in triplicate).

	Goat milk	Warm milk replacer	Acid milk replacer
C 10:0	5.12	0.89	2.78
C 12:0	3.14	7.41	6.18
C 14:0	11.54	4.89	8.15
C 15:0	0.57	0.58	0.84
C 16:0	31.95	15.73	14.52[B]
C 16:1	0.20	4.31	3.45
C 17:0	0.28	0.48	1.48
C 17:1	0.74	0.58	1.49
C 18:0	12.19	16.29	22.07
C 18:1	19.57	37.14	27.24
C 18:2	10.14	6.99	8.12
C 18:3	0.81	0.65	1.15
C 20:0	2.82	0.48	1.37
C 22:0	1.09	0.73	0.32

mulated for kids and permit raising kids with good average daily gains (Arguello et al., 2007). Many authors observed that use of artificial milk replacers is not only good as feeding method to improve the economic balance of goat breeding but it could be also an essential method of prevention for diseases transmitted by ingestion of infected milk or colostrums (Bertolotti et al., 2011; Reina et al., 2010; Vacca et al., 2014) proposing an alternative technique based on the administration of colostrums by healthy goats and successive feeding with milk replacers (Konishi et al., 2011; Reina et al., 2009).

Limited data are available on the effects of milk replacers on kids rearing and meat quality. For this reason, the aim of the work is to evaluate the effect of diet (goat milk, warm milk replacer or acidified milk replacer) on the growth, slaughtering performances, meat quality and fat composition of suckling kids of the Saanen breed.

2. Materials and methods

2.1. Animals

A total of 120 Saanen kids were used for the trial. All the animal management was conducted respecting the animal welfare. They were born within 48 h from 60 goats that had the twin parturition. They were randomly divided into three treatment experimental group, each made up of 40 animals, of both sex, and housed in three different pens. One group was fed with natural milk (NM) by their dams, and kids remained with their mothers until 45 days of life. One group was fed with a milk replacer (MR) and one group was fed with an acid milk replacer (AMR). Kids were individually identified by a plastic numbered neck-collar. Each pen for the two artificially suckling groups was equipped with an automatic suckling machine with 6 suckling stations.

2.2. Milk

All kids involved in the trial naturally assumed colostrums in their first 48 h of life. The two groups artificially suckled, from the third day of life they were separated from their dams. Initially the MR and AMR foals were encouraged to drink milk from a bottle containing respectively milk replacer and acid milk replacer, which was offered to them near the feeding station. Milk continued to be offered via the bottle until the kids started consuming it independently from the feeding station. This occurred within the first 5 h.

The MR group was fed with a commercial kid warm (36–38 °C) milk replacer (Lamlac Instant, VOLAC, Milan, Italy; Table 1), reconstituted at 17% (w/w), continuously mixed (half a liter each time) and offered ad libitum on a 24-h basis. The AMR group was fed with a commercial kid cold acid (21–23 °C) milk replacer (Starter Zero Acido, Cima s.r.l., Castiglione delle Stiviere, Italy); Table 1), reconstituted at 18.5% (w/w), continuously mixed (half a liter each time) and offered ad libitum on a 24 h basis. Fatty acid profile was analyzed in triplicate for each milk used in kids feeding and reported in Table 2.

2.3. Slaughtering, meat sampling and analysis

All kids were weighed (Live weight, LW) and they were slaughtered in a national accredited slaughterhouse, according to current EU regulations (Council Directive of the European Union 95/221EC). After slaughtering, hot carcass weight (CW) was measured and net dressing percentage (DP) was calculated, then carcasses were kept in a chilling room at 4 °C for 48 h.

Warm and cold carcass weights were measured, and warm and cold dressing percentage were calculated. The pelvic limb was dissected in fat, meat and bone and their incidence were calculated. Moreover, *longissimus thoracis* muscle was sampled to perform meat analysis.

Moisture was determined in an oven at 105 °C until a constant weight was reached, proteins were measured with the ISO 937:1978 method (ISO, 1978); intramuscular fat was determined with the ISO 1443:1973 method (ISO, 1973) and ash was calculated with the ISO 936:1998 method (ISO, 1998). Every muscle and subcutaneous tissue sample was homogenized with a mixture chloroform and methanol (1:2, vol/vol) solution for the extraction of total lipids from intramuscular fat, according to the method described by Bligh and Dyer (1959).

The surface colour of kids meat was determined according to the CIE L*, a*, b* (CIE, 1976) colour system using Minolta CR-300 colorimeter (light source D65; Minolta Camera Co. Ltd., Osaka, Japan). Reflectance measurements were collected from a 0° viewing angle with an A pulsed xenon arc lamp with a reading surface of 8 mm diameter. These measurements were performed 24 h after slaughtering in three different points of each sample. Moreover, on each point, three measurements were performed by rotating the detector system of 90° from the previous one, for a total of nine measurements for sample. The 9 readings per sample were made at each time point and averaged for statistical analysis. The colorimeter was calibrated on the Hunter-lab colour space system using a white title (L^* = 99.2, a^* = 1.0, b^* = 1.9). The a* and b* values were used to determine chroma = $(a^2 + b^2)^{1/2}$ and hue (°) = $\tan^{-1}(b/a)$ according to Little (1975) and Mancini and Hunt (2005).

The WHC was measured using the centrifugation method according to Bouton et al. (1971). Samples weighing 3 g were col-